



# Air Force F-22 Fighter Program

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## Summary

Procurement of Air Force F-22 Raptor fighters began in FY1999, and a total of 195 (177 production aircraft, 16 test aircraft, and 2 development aircraft) were procured through FY2009. In the FY2010 budget, the Administration proposed to end F-22 procurement at 187, and Congress approved that termination. The F-22 assembly line in Marietta, GA, has been shut down, with its tools and equipment placed in storage.

Since 2010, operational issues have arisen. Following a November 2010 fatal crash of an F-22 in Alaska, the Air Force recorded at least 25 “physiological incidents” of F-22 pilots reporting hypoxia-like symptoms while flying, possibly indicating oxygen deprivation. Following a lengthy investigation and grounding of the F-22 fleet, the Air Force attributed the oxygen deprivation to “a ‘mosaic’ of interrelated cockpit equipment issues.” Following corrective actions, the F-22 fleet has returned to the air.

The Administration’s proposed FY2013 defense budget requests \$283.9 million in FY2013 procurement funding for modification of in-service aircraft and \$36.7 million to equip Air Logistics Centers to perform F-22 maintenance. The Administration’s proposed FY2013 defense budget also requests a new start program, funded at \$140.1 million in research and development, for the Increment 3.2B software, and \$371.7 million in FY2013 research and development funding for F-22A Squadrons.

The Senate Appropriations Committee markup of the FY2013 defense appropriation bill includes language prohibiting funds from being used to approve or license the sale of the F-22 to other countries. The bill does permit the Department of Defense to conduct studies and design activities to develop a future export version of the aircraft that protects classified and sensitive information. This language is similar to provisions passed by Congress each year since 1998.

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## Introduction

The Air Force F-22 fighter, also known as the Raptor, is “the most capable fighter aircraft ever built, period.”<sup>1</sup> Procurement of F-22s began in FY1999, and a total of 195 (177 production aircraft, 16 test aircraft, and 2 development aircraft) were procured through FY2009.

Ongoing issues for Congress regarding the F-22 program include questions regarding the F-22’s supply of oxygen to its pilots, the possible resumption of production, the reliability and maintainability of in-service Raptors, the F-22 modernization program, and the potential sale of F-22s to other countries.

Congress’s decisions on all these issues could affect Department of Defense (DOD) capabilities and funding requirements, the U.S. tactical aircraft industrial base, and U.S. relations with other countries.

## Recent Developments

### F-22 Oxygen Issues

Following a November 2010 fatal crash of an F-22 in Alaska, the Air Force began an effort to understand why pilots were “reporting hypoxia-like symptoms in the air. Hypoxia is a condition that can bring on nausea, headaches, fatigue or blackouts when the body is deprived of oxygen.”<sup>2</sup> At least 25 “physiological incidents” were recorded among F-22 pilots; 14 prior to the Raptor being grounded from May to September 2011, for investigation of the issue, and at least 11 subsequently.<sup>3</sup>

In an August 2012 review, the Air Force announced that the oxygen deprivation issue was due to “a ‘mosaic’ of interrelated cockpit equipment issues that led to a chain reaction of glitches resulting in symptoms similar to hypoxia.”<sup>4</sup> The equipment problems included issues with valves in vests designed to help pilots breathe during high-g maneuvers; improper “scheduling,” or programming, of those vests; and effects of the charcoal canisters added by the Air Force during the investigation in order to reduce possible toxins in the oxygen supply.<sup>5</sup>

While the valve has performed satisfactorily for pilots of older F-15 and F-16 fighters, the F-22 is designed to fly at higher altitudes, which requires continuously pumping more oxygen to the pilots, Lyon said. The valve wasn’t strong enough to prevent that higher pressure oxygen from inflating the pilots’ vests at lower altitudes.<sup>6</sup>

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<sup>1</sup> Richard Aboulafia, Teal Group aerospace analyst, quoted in Jim Wolf, “U.S. to mothball gear to build top F-22 fighter,” *Reuters.com*, December 13, 2011.

<sup>2</sup> W.J. Hennigan, “Air Force Safety Measures Attempt To Address F-22 Raptor Concerns,” *Los Angeles Times*, May 12, 2011.

<sup>3</sup> Jennifer Hlad, “Air Force Still Searching For Cause Of Sickness Among F-22 Pilots,” *Stars & Stripes*, May 9, 2012.

<sup>4</sup> Michael Fabey, “USAF Deciphers ‘Mosaic’ Of F-22 Oxygen Supply Problems,” *Aerospace Daily*, August 1, 2012.

<sup>5</sup> *Ibid.*

<sup>6</sup> David Lerman, “Air Force Targets Valve To Fix F-22 Jet’s Oxygen Problems,” *Bloomberg News*, August 1, 2012. See also, *inter alia*, Pat Host, “Air Force Blames Faulty F-22 Pressurization ‘Schedule’ For Pilots’ Hypoxia-Like (continued...)”

... the Air Force did “rudimentary testing” on the valve some years ago and found that it caused the high-pressure vest to inflate early, hampering pilot mobility. However, the vest was found to be unnecessary on the F-15 and F-16. When the vest was re-introduced on the F-22 with the same valve, the problem wasn't detected.<sup>7</sup>

Also in response to the 2010 crash, the Air Force is “replacing handles that engage the F-22 Raptor fighter jet’s emergency oxygen system.” Difficulty in operating the backup oxygen system was cited as contributing to the crash.<sup>8</sup>

Beginning April 4, 2013, Air Combat Command returned F-22s that had had emergency backup oxygen systems installed to unrestricted flight status. The full fleet was expected to be in this status by July 2014.<sup>9</sup>

## **Production Shutdown**

On May 3, 2012, Lockheed Martin delivered the 195<sup>th</sup> F-22 to the Air Force, completing the fleet.<sup>10</sup> That final aircraft had come off the Lockheed Martin production line in Marietta, GA, on December 13, 2011.<sup>11</sup> Following its assembly, Lockheed Martin had begun to store “a total of more than 30,000 jigs, fixtures and other ‘tooling’ used to build the plane” in order to “leave open an option to restart the premier plane’s production relatively cheaply.”<sup>12</sup> Lockheed Martin had also documented the assembly process, including videotaping each step of assembly, in order to more quickly train workers to assemble F-22s in the event of a production line restart.<sup>13</sup>

About 5,600 Lockheed employees worked on the F-22 program at its peak in 2005, including 944 in Marietta. The current number is 1,650 companywide, 930 in Marietta.... However, 600 Marietta employees will handle technical support and modernizations for the existing F-22 fleet.<sup>14</sup>

## **Potential Production Restart**

Conscious of DOD’s having preserved the F-22 production tooling and Lockheed Martin’s actions to ease a potential restart, a number of commentators have posited that the F-22 could be returned to production, whether to enable foreign sales, increase fleet numbers, or act as a hedge against difficulties in the F-35 program.

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Symptoms,” *Defense Daily*, August 1, 2012; Dave Majumdar, “USAF working on ‘non-minor fix’ for F-22 oxygen problem,” *FlightGlobal.com*, September 25, 2012; and Hugh Lessig, “Raptor Problems: No One Cause,” *Newport News Daily Press*, August 1, 2012.

<sup>7</sup> Hugh Lessig, “Raptor Problems: No One Cause,” *Newport News Daily Press*, August 1, 2012.

<sup>8</sup> Mary Pemberton, “F-22 fighters retrofitted after Alaska crash,” *Air Force Times*, March 20, 2012.

<sup>9</sup> Brian Everstine, “Flight Restrictions Lifted For F-22s With Auto Oxygen System,” *DefenseNews.com*, April 4, 2013.

<sup>10</sup> “Lockheed Martin Delivers Final F-22 Raptor To Air Force,” *Defense Daily*, May 3, 2012.

<sup>11</sup> Jim Wolf, “U.S. to mothball gear to build top F-22 fighter,” *Reuters.com*, December 13, 2011.

<sup>12</sup> *Ibid.*

<sup>13</sup> CRS interview with Robert Stevens, CEO of Lockheed Martin, September 14, 2012, and Stephanie Stinn, “Last of the Line: Raptor 4195 Delivered,” *Code One*, Vol. 27, Number 2 2012, p. 3.

<sup>14</sup> Janel Davis, “Lockheed Rolls Last Raptor Off The Line,” *Atlanta Journal-Constitution*, December 14, 2011, p. 15.

The potential cost of a restart, and its concomitant effect on F-22 unit costs, is unclear. By one account:

Bringing back the F-22 line would take less than \$200 million, “a fraction of the costs seen in previous line restarts of other weapons systems,” Alison Orne, a Lockheed spokeswoman, said by email, citing preliminary analysis.<sup>15</sup>

In a 2009 study conducted for the Air Force prior to the termination decision, the RAND Corporation analyzed the costs of four industrial scenarios: shutting down the F-22 line permanently; restarting the line after a two-year shutdown; maintaining low-rate production; and maintaining full-rate production, in each case to produce an additional 75 F-22s.<sup>16</sup> This study found that shutdown, hiatus, and restart would cost \$513 million, or \$434 million more than termination.

According to another report, in 2010, “Lockheed officials ... told Japanese leaders it would cost \$900 million to re-open the production line.”<sup>17</sup>

Given the range of possible restart costs and the uncertainty of how many aircraft would be purchased, it is not possible to estimate the unit cost of any F-22s built following a potential production restart.

## Background

### The F-22 in Brief

The F-22A Raptor<sup>18</sup> is the world’s most capable air-to-air combat aircraft. It also has an air-to-ground (i.e., attack) capability.<sup>19</sup> The F-22 incorporates a high degree of stealth, as well as supercruise,<sup>20</sup> thrust-vectoring for high maneuverability,<sup>21</sup> and integrated avionics that fuse information from on-board and off-board sensors.

The F-22 and the multi-service F-35 Joint Strike Fighter (JSF) are considered the world’s first (and to date only) fifth-generation tactical aircraft. Fifth-generation aircraft incorporate the most

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<sup>15</sup> Jim Wolf, “U.S. to mothball gear to build top F-22 fighter,” *Reuters.com*, December 13, 2011.

<sup>16</sup> Obaid Younossi, Kevin Brancato, John C. Graser, Thomas Light, Rena Rudavsky, Jerry M. Sollinger, *Ending F-22A Production: Costs and Industrial Base Implications of Alternative Options*, RAND Project Air Force, monograph MG 797, Santa Monica, CA, 2010, [http://www.rand.org/pubs/monographs/2010/RAND\\_MG797.pdf](http://www.rand.org/pubs/monographs/2010/RAND_MG797.pdf).

<sup>17</sup> Loren Thompson, “consultant for Lockheed Martin and other defense companies,” cited in Michael Hoffman, “Romney wants to buy more F-22s,” *DoD Buzz*, September 10, 2012.

<sup>18</sup> The F-22 is referred to formally as the F-22A, meaning the first version of the F-22. As no other versions of the F-22 are currently planned, this CRS report refers to the aircraft as the F-22.

<sup>19</sup> Although the F-22 was originally conceived as an air superiority fighter with minimal air-to-ground capability, the Air Force subsequently placed more emphasis on F-22’s air-to-ground capability. In September 2002, in recognition of the aircraft’s air-to-ground capability, the F-22 was redesignated the F/A-22, with the A standing for attack. In December 2005, the Air Force changed the aircraft’s designation back to F-22.

<sup>20</sup> Supercruise is the ability to cruise at supersonic speeds without using engine afterburners. The F-22 is expected to have a level speed of about Mach 1.7 using afterburners and a cruise speed of about Mach 1.5 without afterburners.

<sup>21</sup> The F-22’s two Pratt & Whitney F-119 turbofan engines are equipped with thrust-vectoring nozzles.

modern technology and are considered to be generally more capable than earlier-generation (e.g., fourth-generation and below) aircraft.<sup>22</sup>

The F-22 is intended to replace the Air Force's aging F-15 air superiority fighters, while the F-35A (the Air Force version of the F-35) is intended to replace the service's aging F-16 fighters and A-10 attack aircraft. The F-22 is more stealthy than the F-35,<sup>23</sup> and more capable than the F-35 in air-to-air combat. The F-35A is intended to be a more affordable complement to the F-22, and is a strike fighter—a dual-role aircraft with significant capability in both air-to-ground (strike) and air-to-air (fighter) operations.<sup>24</sup> If the F-15/F-16 combination represented the Air Force's earlier-generation "high-low" mix of air superiority fighters and more-affordable dual-role aircraft, then the F-22/F-35A combination might be viewed as the Air Force's intended future high-low mix of air superiority fighters and more-affordable dual-role aircraft.<sup>25</sup> The Air Force states that:

Fifth generation fighters like the F-22A and the F-35 are key elements of our Nation's defense and ability for deterrence. As long as hostile nations recognize that U.S. airpower can strike their vital centers with impunity, all other U.S. Government efforts are enhanced, which reduces the need for military confrontation....

Both the F-22A and the F-35 represent our latest generation of fighter aircraft. We need both aircraft to maintain the margin of superiority we have come to depend upon, the margin that has granted our forces in the air and on the ground freedom to maneuver and to attack. The F-22A and F-35 each possess unique, complementary, and essential capabilities that together provide the synergistic effects required to maintain that margin of superiority across the spectrum of conflict....

The F-22A Raptor is the Air Force's primary air superiority fighter, providing unmatched capabilities for air supremacy, homeland defense and cruise missile defense for the Joint team. The multi-role F-22A's combination of speed, stealth, maneuverability and integrated avionics gives this remarkable aircraft the ability to gain access to, and survive in, high threat environments. Its ability to find, fix, track, and target enemy air- and surface-based threats ensures air dominance and freedom of maneuver for all Joint forces.<sup>26</sup>

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<sup>22</sup> A November 2009 press report states that the first flight of Russia's first fifth-generation fighter—the Sukhoi T-50 prototype—was slipping from late 2009 into 2010, and that an operational version of the aircraft was expected to enter service with the Russian air force in the latter half of the next decade. (Douglas Barrie, "Russian Fifth-Gen Fighter Will Not Fly This Year," *Aerospace Daily & Defense Report*, November 19, 2009: 2.) An August 2009 press report quoted the aircraft's designer as stating that the aircraft was scheduled to make its first flight by the end of 2009, or perhaps in January or February 2010. (Dmitry Solovyov, "Sukhoi Says New Fighter Will Fly In '09," *Moscow Times*, August 21, 2009.)

<sup>23</sup> A November 13, 2009, press article states that "the F-22 had a -40dBsm all-aspect reduction requirement [i.e., a requirement to reduce the radar reflectivity of the F-22 when viewed from all angles by 40 decibels per square meter], while the F-35 came in at -30dBsm with some gaps in coverage." (David A. Fulghum and Bradley Perrett, "Experts Doubt Chinese Stealth Fighter Timeline," *Aerospace Daily & Defense Report*, November 13, 2009: 1-2.)

<sup>24</sup> For more on the F-35 program, see CRS Report RL30563, *F-35 Joint Strike Fighter (JSF) Program*, by Jeremiah Gertler.

<sup>25</sup> The term *high-low mix* refers to a force consisting of a combination of high-cost, high-capability aircraft and lower-cost, more-affordable aircraft. Procuring a high-low mix is a strategy for attempting to balance the goals of having a certain minimum number of very high capability tactical aircraft to take on the most challenging projected missions and of being able to procure tactical aircraft sufficient in total numbers within available resources to perform all projected missions.

<sup>26</sup> Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant (continued...)

## Program Origin and Milestones

The F-22 program was initiated in the early 1980s with the aim of developing a highly capable successor to the F-15 that would be capable of defeating all known and projected enemy fighters, including those being developed at the time by the Soviet Union.<sup>27</sup> The F-22 program was given Milestone I approval in October 1986. The first flight of an F-22 industry prototype occurred in August 1990,<sup>28</sup> and the first flight of a development version of the aircraft occurred in September 1997.<sup>29</sup> The program was granted approval for Low Rate Initial Production (LRIP) in August 2001, and the first LRIP F-22 was delivered in June 2003. The F-22 achieved Initial Operational Capability (IOC) in December 2005.<sup>30</sup>

Operational F-22s are currently assigned to Joint Base Langley-Eustis, Virginia; Joint Base Elmendorf-Richardson, Alaska; Holloman Air Force Base (AFB), New Mexico; and Joint Base Pearl Harbor-Hickam, Hawaii. A training unit is at Tyndall AFB, Florida. Tactics development is conducted at Nellis AFB, Nevada, and some testing continues at Edwards AFB, California.<sup>31</sup>

Lockheed Martin in the past has studied the idea of a fighter-bomber version of the F-22 called the FB-22, but the Air Force currently has no program to develop or acquire such an aircraft.<sup>32</sup>

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General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5), Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ), [and] Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8), May 20, 2009, pp. 7-8.

<sup>27</sup> In the early 1980s, the Air Force began to develop a stealth aircraft called the Advanced Tactical Fighter (ATF), which was then expected to enter service in the 1990s as the replacement for the F-15. The ATF program was initiated in response to advances in Soviet combat aircraft that were expected to occur in the 1990s. A naval variant of the ATF that could operate from aircraft carriers—the NATF—was initiated as the replacement for the Navy’s F-14 fighter, but the NATF program was subsequently terminated.

<sup>28</sup> To help control ATF costs, DOD used competitive prototypes for ATF airframes, engines, and avionics. The Air Force selected two teams of contractors to develop ATF airframe prototypes: Lockheed teamed with Boeing and General Dynamics; and Northrop teamed with McDonnell Douglas. On October 31, 1986, the Air Force awarded each team a \$691-million fixed-price contract to build two prototypes. Lockheed’s prototype was designated the YF-22, while Northrop’s was designated the YF-23. The prototypes were powered by new-design engines. One YF-22 prototype and one YF-23 prototype were powered by Pratt & Whitney’s F119 engine, while the other YF-22 prototype and YF-23 prototype were powered by General Electric’s F120 engine. The Air Force announced in 1989 that the full-scale development phase would be delayed to allow more time for development of engines and avionics. Each contractor team reportedly spent over \$1 billion in company funds to develop competing their prototypes, which were flight-tested and evaluated in late 1990.

<sup>29</sup> On April 23, 1991, the Air Force selected the Lockheed’s YF-22 design, as powered by Pratt & Whitney’s F119 engine, for development as the F-22. Air Force Secretary Donald Rice stated that the choice was based on confidence in the ability of the Lockheed team and Pratt & Whitney to produce the aircraft and its engine at projected costs. Rice emphasized the importance of the Lockheed team’s management and production plans, and added that the YF-22 offered better reliability and maintainability. Neither design was judged significantly more maneuverable or stealthy than the other. On August 2, 1991, contracts totaling \$11 billion were awarded to Lockheed and Pratt & Whitney for engineering and manufacturing development (EMD) of the F-22, then including 11 development/prototype aircraft.

<sup>30</sup> On December 12, 2005, the Air Force’s Air Combat Command declared that the first squadron of 12 F-22s—27<sup>th</sup> Fighter Squadron of the 1<sup>st</sup> Fighter Wing, based at Langley Air Force Base (AFB)—had achieved Initial Operational Capability (IOC). On January 21, 2006, the F-22 flew its first operational sorties, taking part in an on-going air superiority mission over the United States.

<sup>31</sup> Stephanie Stinn, “Last of the Line: Raptor 4195 Delivered,” *Code One*, Vol. 27, Number 2 2012, p. 3.

<sup>32</sup> The FB-22, which would employ a delta wing (i.e., a triangular shaped wing), would have double the F-22’s range and a significantly larger internal payload. Some observers have estimated that the FB-22 could carry up to 30 250-lb (continued...)

## F-22 Contractors and Employment

### Contractors

The major contractors for the F-22 program were Lockheed Martin of Marietta, GA, and Fort Worth, TX, along with Boeing of Seattle, WA, for the F-22's airframe; and United Technologies of East Hartford, CT (the parent firm of engine maker Pratt & Whitney) for the F-22's F119 engines.

A map provided by Lockheed shows a total of roughly 1,040 F-22 supplier firms in 44 states (all but Alaska, Hawaii, North Dakota, South Dakota, West Virginia, and Wyoming).<sup>33</sup>

### Employment

Lockheed stated that as of 2009, the F-22 program supported a total of 8,800 direct jobs at Lockheed's Marietta, GA, and Fort Worth, TX, locations, and at Boeing and Pratt & Whitney. Lockheed estimated, on the basis of purchase order receipts, that the F-22 program supported an additional 16,200 supplier-firm jobs in 44 states around the country. Lockheed combined these two figures to estimate that the F-22 supported a total of about 25,000 direct jobs. Using a multiplier of 2.8 to estimate jobs elsewhere in the economy that were indirectly supported by these 25,000 jobs, Lockheed estimated that an additional 70,000 jobs were indirectly supported by the F-22 program. Lockheed combined the figures of 25,000 and 70,000 to estimate that a total of 95,000 jobs were supported either directly or indirectly by the F-22 program.<sup>34</sup>

A map provided by Lockheed shows roughly 25,800 direct F-22-related jobs in 44 states. According to the map, states with more than 1,000 direct F-22-related jobs included California

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Small Diameter Bombs. (Richard Whittle, "F-22 Bomber Studied," *Dallas Morning News*, July 30, 2002; Frank Wolfe, "Sambur: F-22 Must Prove Itself Before FB-22 Becomes Formal Program," *Defense Daily*, March 4, 2002.) These potential improvements in range and internal payload would likely result in reduced performance compared to the F-22 in other areas, such as acceleration and maneuverability.

Some Air Force leaders in the past have expressed some enthusiasm for the FB-22 idea. In 2002, Secretary of the Air Force James Roche reportedly favored the FB-22 as the potential platform of choice for providing better close air support for tomorrow's ground forces. (Ron Laurenzo, "Roche Envisions Close Air Support F-22," *Defense Week*, July 1, 2002.) Roche suggested in testimony to Congress in 2003 that up to 150 FB-22s could be procured, with full-rate production achievable by FY2011, if development funds were committed in FY2004. (Lorenzo Cortes, "Air Force Issues Clarification on FB-22, FY'11 Delivery Date Possible," *Defense Daily*, March 10, 2003.) Some Air Force leaders in the past have said the FB-22 could serve as a bridge between the current bomber force and a next-generation long-range bomber. Other Air Force leaders have reportedly shown less enthusiasm in the FB-22 concept. Air Force acquisition chief Marvin Sambur said in 2002 that the F-22A's difficulties would have to be solved before the FB-22 could be considered. (Bill Sweetman, "Smarter Bomber," *Popular Science*, June 25, 2002.)

Some observers argue that the FB-22 could be developed and produced economically by reusing the F-22's cockpit, engines, computer systems, production methods, and materials. Other observers argue that redesigning an aircraft to perform a new mission is difficult and usually expensive. Some observers estimate that developing the FB-22's modified airframe could cost up to \$1 billion. Other observers have questioned the potential cost effectiveness attractiveness of a medium-range bomber with a payload smaller than that of current long-range bombers.

<sup>33</sup> Lockheed map entitled "F-22 Raptor[:.] The 2009 Industrial Base," provided to CRS by e-mail on July 13, 2009. The map shows four states with no suppliers (North Dakota, South Dakota, West Virginia, Wyoming) and does not depict two other states (Alaska and Hawaii).

<sup>34</sup> Source: Lockheed e-mail to CRS, July 13, 2009.

(6,532 jobs), Texas (3,526), Georgia (2,821), Connecticut (2,205), New Hampshire (2,197), Washington (1,491), and Florida (1,025). The map shows several states with a few hundred to several hundred direct F-22-related jobs each, and a number of states with fewer than 100 (in some cases fewer than 25) direct F-22-related jobs each. The map shows four states—North Dakota, South Dakota, West Virginia, and Wyoming—as having no direct F-22-related jobs in 2009. The map does not depict Alaska or Hawaii.<sup>35</sup>

## Procurement Quantities

### Planned Total Procurement Quantity

Since the submission to Congress in early 2005 of the FY2006 budget, DOD plans called for procuring a total of about 187 operational F-22s. The final figure of 195 includes

- 177 production aircraft,
- 15 Production Representative Test Vehicle (PRTV) aircraft,
- 1 replacement test aircraft, and
- 2 Engineering and Manufacturing Development (EMD) aircraft funded with research and development funding.<sup>36</sup>

The final figure of 177 production aircraft includes 4 F-22s whose procurement was included in the FY2009 supplemental appropriations act.

The Air Force originally envisaged a production run of 750 F-22s. The figure was reduced to 648 in 1991. DOD's 1993 Bottom-Up Review reduced the planned number of production F-22s to 438 (plus 4 pre-production versions, later reduced to 2), which was enough to support 4 F-22 fighter wings in a total Air Force force structure of 20 wings (13 active; 7 Reserve/National Guard). The 1997 Quadrennial Defense Review (QDR) reduced the planned number of production F-22s to 339, which was enough to support three F-22 fighter wings in a 20-wing force structure (12 active; 8 Reserve/National Guard). **Table 1** shows planned total numbers of F-22s in the budget submissions for FY1999 to FY2010.

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<sup>35</sup> Lockheed map entitled "F-22 Raptor[:]: The 2009 Industrial Base," provided to CRS by e-mail on July 13, 2009.

<sup>36</sup> Some DOD documents show slightly different planned procurement totals, such as 184 (a figure that includes one replacement test aircraft) or 181 (a figure that includes 172 production aircraft and 9 non-production aircraft). The most commonly cited figure is 183.

**Table 1. Planned Total Number of Production F-22s**

As shown in budget submissions for FY1991 to FY2010

Budget submission	Planned number of production F-22s	Planned total number of F-22s <sup>a</sup>
FY1991	648	n/a
FY1992	648	n/a
FY1993	442	n/a
FY1994	442	n/a
FY1995	442	n/a
FY1996	442	n/a
FY1997	442	n/a
FY1998	341	n/a
FY1999	339	n/a
FY2000	339	n/a
FY2001	333	n/a
FY2002	333	339
FY2003	333	339
FY2004	270	276
FY2005	271	277
FY2006	172	179
FY2007	176	183
FY2008	175	183
FY2009	175	183
FY2010	175 <sup>b</sup>	183 <sup>b</sup>

**Source:** Prepared by CRS based on Air Force information paper of July 8, 2009, provided to CRS on July 9, 2009 (for FY1991-FY1998), and DOD budget submissions (for FY1999-FY2010).

- a. This total includes production F-22s from the previous column, plus 6 Production Representative Test Vehicle (PRTV) II aircraft, plus (beginning in FY2006) 1 or 2 EMD aircraft funded with research and development funding.
- b. The proposed FY2010 budget was submitted to Congress in early May 2009, prior to the completion of action on the FY2009 supplemental appropriations act, and consequently does not reflect four additional F-22s whose procurement cost was completed in the FY2009 supplemental appropriations act. If these four aircraft had been included in the FY2010 budget submission, the submission would have shown 179 production F-22s and a total of 187 F-22s.

## Annual Procurement Quantities

**Table 2** shows annual procurement quantities for the 195 F-22s procured through FY2009.

The 64 F-22s procured in FY2007-FY2009 include 20 F-22s per year that were procured under a multiyear procurement (MYP) arrangement, plus the four additional F-22s whose procurement cost was completed in the FY2009 supplemental appropriations act.

**Table 2. Annual Procurement Quantities of F-22s**

<b>FY</b>	<b>Quantity Planned</b>	<b>Quantity Produced</b>
FY91	0	9 <sup>a</sup>
FY99	2	2
FY00	0	6 <sup>b</sup>
FY01	10	10
FY02	13	13
FY03	21	21
FY04	22	22
FY05	24	21
FY06	23	23
FY07	20	21 <sup>c</sup>
FY08	20	20
FY09	20	24 <sup>d</sup>
<b>Total through FY09</b>	<b>188</b>	<b>195</b>

**Source:** Prepared by CRS based on DOD and Lockheed Martin data.

- a. The nine Production Representative Test Vehicle I aircraft funded in FY91 were not originally intended as operational aircraft, but were counted as such in subsequent budget submissions.
- b. The six Production Representative Test Vehicle II aircraft funded in FY00 were not counted as operational in subsequent budget submissions.
- c. The FY07 total includes one additional F-22 to replace a lost test aircraft.
- d. Four aircraft were funded through the FY09 supplemental appropriation.

## Costs and Funding

### Estimated Total Program Cost<sup>37</sup>

As of December 31, 2010, the final Selected Acquisition Report for F-22 procurement, DOD estimated the total acquisition cost (meaning the sum of research and development cost, procurement cost, and military construction [MilCon] cost) of a 179-aircraft F-22 program at about \$67.3 billion in then-year dollars (meaning dollars across various years that are not adjusted for inflation). This figure includes about \$32.4 billion in research and development costs, about \$34.2 billion in procurement costs, and \$676.6 million in MilCon costs.

As of December 31, 2010, the 179-aircraft F-22 program had a Program Acquisition Unit Cost (or PAUC, which is the program's total acquisition cost divided by the total number of aircraft acquired [including non-production aircraft]) of \$369.5 million in then-year dollars, and an Average Unit Procurement Cost (which is the program's total procurement cost divided by 179 production aircraft) of \$185.7 million in then-year dollars.

<sup>37</sup> Figures in this section are taken from the December 31, 2010, Selected Acquisition Report (SAR) for the F-22 program.

## Legislated Limits on F-22 Costs

Beginning in FY1998, the F-22 program operated under legislated limits on total engineering and manufacturing development (EMD) cost and on total production cost. The limit on EMD cost was repealed as part of action on the FY2002 defense budget, leaving in place the limit on total production cost.<sup>38</sup> The limit on total production cost is adjustable for inflation after September 30, 1997, and for changes in federal, state, and local laws enacted after September 30, 1997. For FY2009, the adjusted limit on total production cost was \$37.6432 billion in then-year dollars.<sup>39</sup> The 187-aircraft F-22 program appears to be more than \$3 billion below this cap.<sup>40</sup>

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<sup>38</sup> The history of the legislated limits is as follows:

- Section 217 of the FY1998 defense authorization act (H.R. 1119/P.L. 105-85 of November 18, 1997) limited the total cost of the F-22 program's engineering and manufacturing development (EMD) phase to \$18.688 billion, and the total cost of the F-22 program's production phase to \$43.4 billion. The section stated that both of these figures could be adjusted for inflation after September 30, 1997, and for changes in federal, state, and local laws enacted after September 30, 1997.
- Section 8125 of the FY2001 defense appropriations act (H.R. 4576/P.L. 106-259 of August 9, 2000) limited the combined cost of the F-22 program's EMD and production phases to \$58.0282 billion. The section stated that figure could be adjusted for inflation as under Section 217 of the FY1998 defense authorization act (i.e., for inflation and for changes in federal, state, and local laws). In an apparent reference to Section 217 of the FY1998 defense authorization act (see above), Section 8125 also stated that "This section supersedes any limitation previously provided by law on the amount that may be obligated or expended for engineering and manufacturing development under the F-22 aircraft program and any limitation previously provided by law on the amount that may be obligated or expended for the F-22 production program."
- Section 219 of the FY2001 defense authorization act (H.R. 4205/P.L. 106-398 of October 30, 2000—the conference report on H.R. 4205 [H.Rept. 106-945 of October 6, 2000] enacted the provisions of H.R. 5408), which was signed into law after the FY2001 defense appropriations act (see above)—amended Section 217 of the FY1998 defense authorization act by permitting the cost limit on the F-22 program's EMD phase to be increased by not more than 1.5% if the Director of Operational Test and Evaluation, after consulting with the Under Secretary of Defense for Acquisition, Technology, and Logistics, determines that the increase is necessary in order to ensure adequate testing. In an apparent reference to Section 8125 of the FY2001 defense appropriations act (see above), Section 219 also stated that the individual cost limits on the EMD and production phases of the F-22 program established by Section 217 of the FY1998 defense authorization act shall continue to apply "without regard to any provision of law establishing a single limitation on amounts obligated and expended for engineering and manufacturing development and for production for that program."
- Section 213 of the FY2002 defense authorization act (S. 1438/P.L. 107-107 of December 28, 2001) repealed the limit on the total cost of the F-22 program's EMD phase established by Section 217 of the FY1998 defense authorization act, leaving in place Section 217's limit on the total cost of the F-22 program's phase. Section 213 also repealed Section 8125 of the FY2001 defense appropriations act, and repealed the part of Section 219 of the FY2001 defense authorization act that stated (in an apparent reference to Section 8125) that the individual cost limits on the EMD and production phases of the F-22 program established by Section 217 of the FY1998 defense authorization act shall continue to apply "without regard to any provision of law establishing a single limitation on amounts obligated and expended for engineering and manufacturing development and for production for that program."

<sup>39</sup> Source: Air Force information paper of July 8, 2009, provided to CRS on July 9, 2009.

<sup>40</sup> As of December 31, 2007, the 183-aircraft F-22 program had a total estimated procurement cost of \$33.5 billion in then-year dollars. The four additional F-22s whose procurement cost was completed with \$600 million in funding in the FY2009 supplemental appropriations act would increase that figure to something above \$34 billion in then-year dollars.

## FY2013 F-22 Funding

The Administration's proposed FY2013 defense budget requests \$283.9 million in FY2013 procurement funding for modification of in-service aircraft and \$36.7 million to equip Air Logistics Centers to perform F-22 maintenance. The Administration's proposed FY2013 defense budget also requests a new start program, funded at \$140.1 million in research and development, for the Increment 3.2B software; and \$371.7 million in FY2013 research and development funding for F-22A Squadrons.

## Modernization and Sustainment of In-Service F-22s

The Air Force in 2003 established a program to modernize its in-service F-22s. The program includes upgrades to the aircraft's air-to-ground and intelligence, surveillance and reconnaissance (ISR) capabilities, to be applied in four scheduled increments.

**Table 3. F-22A Modernization Increments**

Increment	GAO description <sup>a</sup>	Air Force description <sup>b</sup>
Increment 2	The initial phase of modernization, addressed some requirements deferred from the acquisition program and added some new ground attack capability. It has been fielded.	Allows the Block-20 planes to launch guided Joint Direct Attack Munitions at supersonic speeds and gives the fighter a souped-up Advanced Medium-Range Air-to-Air Missile capability.
Increment 3.1	Began fielding in November 2011 and adds enhanced radar and enhanced air-to-ground attack capabilities.	Upgrades the APG-77 AESA radar to enable synthetic aperture radar ground mapping capability, provides the ability to self-target JDAMs using on-board sensors, and allows F-22As to carry and employ eight Small Diameter Bombs (SDB).
Increment 3.2A	A software upgrade to increase the F-22A's electronic protection, combat identification, and Link-16 communications and data link capabilities.	(Increments 3.2A and B) Features the next generation data-link, improved SDB employment capability, improved targeting using multi-ship geo-location, automatic ground collision avoidance system (Auto GCAS) and the capability to employ our enhanced air-to-air weapons (AIM-120D and AIM-9X).
Increment 3.2B	Will increase the F-22A's electronic protection, geo-location, and Intra Flight Data Link (IFDL) capabilities, and adds AIM-9X and AIM-120D missiles.	

a. U.S. Government Accountability Office, *Tactical Aircraft: F-22A Modernization Program Faces Cost, Technical, and Sustainment Risks*, 12-447, May 2012, <http://www.gao.gov/assets/600/590593.pdf>.

b. Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5), Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ), [and] Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8), May 20, 2009, pp. 8-9.

## GAO Assessment of F-22 Modernization Program

A May 2012 Government Accountability Office (GAO) report assessing major DOD weapon acquisition programs found that “total projected cost of the F-22A modernization program and related reliability and maintainability improvements more than doubled since the program started—from \$5.4 billion to \$11.7 billion—and the schedule for delivering full capabilities slipped 7 years, from 2010 to 2017.”<sup>41</sup> GAO cited “(1) additional requirements, (2) unexpected problems and delays during testing, and (3) research, development, testing, and evaluation funding fluctuations” as contributing to the cost increases and delays. GAO also found that “(p)rogram accountability and oversight have been hampered by how the modernization program was established, managed, and funded,” as the F-22 modernization program has not been treated as a major defense acquisition program (MDAP). Beginning with Increment 3.2B, future F-22 modernization programs will be managed as MDAPs. Further, in its report accompanying the FY2013 Defense Authorization Act, the Senate Armed Services Committee included language stating, “The committee believes the category ‘major defense acquisition programs’ is not limited only to programs that are acquiring brand new weapon systems, and that any F-22A program for modifications or upgrades, if it would otherwise meet the statutory definition of a major defense acquisition program, should be treated that way.”<sup>42</sup>

## Senate Armed Services Language on F-22 Sustainment

F-22 sustainment costs—the funds expended to maintain and operate a system following its procurement—have also attracted congressional attention. In its report accompanying the FY2013 defense authorization act, the Senate Armed Services Committee included language concerning alternate methods of sustaining the F-22 fleet:

### *F-22A Raptor Sustainment*

In addition to the near-term modernization, sustainment over the life cycle of a weapon system represents a significant expenditure of resources. On average, about two-thirds of the total life cycle cost of a major defense system lies in post-production—in its operation and sustainment over its useful life. If that rule were to hold true, with a charge of roughly \$79.0 billion to buy the F-22A, the Air Force could be facing a demand for roughly \$160.0 billion in F-22A sustainment costs. Moreover, under its ‘structures retrofit program’, over the next few years the Air Force will need more than \$100.0 million to retrofit the F-22A fleet just to ensure these aircraft can fly for the full 8,000 hours for which they were designed. Over just the last 2 years, the Air Force issued sole-source contracts for sustainment of the F-22A fleet to the prime contractor totaling almost \$1.4 billion.

The Air Force recently completed an F-22A sustainment strategy review that concluded that a joint contractor/government approach could save more than \$1.0 billion in sustainment costs over the life of the aircraft. The committee believes that the Air Force must transition its sustainment strategy to adopt the least expensive sustainment strategy now, while continuing to be aggressive in exploring opportunities to compete F-22A sustainment work.<sup>43</sup>

<sup>41</sup> U.S. Government Accountability Office, *Tactical Aircraft: F-22A Modernization Program Faces Cost, Technical, and Sustainment Risks*, 12-447, May 2012, <http://www.gao.gov/assets/600/590593.pdf>.

<sup>42</sup> U.S. Congress, Senate Committee on Armed Services, Report to accompany S. 3254, the National Defense Authorization Act for Fiscal Year 2013, 112<sup>th</sup> Cong., June 4, 2012, S.Rept. 112-173.

<sup>43</sup> U.S. Congress, Senate Committee on Armed Services, Report to accompany S. 3254, the National Defense (continued...)

## Potential Sale of F-22s to Other Countries

### Annual Provision Prohibiting Foreign Sales of F-22s (Obey Amendment)

Annual DOD appropriations acts since FY1998 have included a provision known as the Obey amendment that prohibits the use of funds made available in each act to approve or license the sale of the F-22 to any foreign government.<sup>44</sup> Congress from time to time has reconsidered this annual prohibition. The Senate Appropriations Committee mark of H.R. 5856, the Department of Defense Appropriations Bill, 2013, includes this language.

### Potential Interest of Other Countries in Purchasing F-22s

Japan's fighter force includes, among other aircraft, about 200 F-15s and about 90 aging F-4s. To replace the F-4s, Japan reportedly wanted to purchase 40 to 50 new fighters. The effort to procure the replacement fighters is called the FX program. (A projected subsequent effort to replace the F-15s is known as the FXX program.)

Secretary of Defense Robert Gates reportedly recommended the F-35 Lightning II over the F-22 and other candidates in a meeting with Japan's defense minister on May 1, 2009, but Japan reportedly still preferred to purchase the F-22. In December, 2011, Japan chose the F-35. Congress was notified of the proposed sale in May 2012.<sup>45</sup> However, former Air Force Secretary Michael Wynne "said by email that Japan and Australia would 'immediately partner' to restart the line if Congress lifted the F-22 export ban."<sup>46</sup>

Japan may not be the only foreign country interested in purchasing F-22s. A November 9, 2009, press report states:

Legally, the F-22 Raptor cannot be sold outside the United States. But the plane will be at the Dubai Air Show after having been absent from the Paris Air Show this summer.

Why the Raptor will fly in Dubai and didn't fly in Paris has to do with the debate over how many F-22s the U.S. Air Force is buying, observers said.

Leading up to the Paris Air Show, discussion was still heated over that number. Now that the total has been effectively limited, bringing the plane to an international air show is a less sensitive proposition, said defense and aerospace analyst Loren Thompson of the Lexington Institute in Arlington, Va.

"The F-22 did not make it to the Iraq war and did not make it to the Paris Air Show, but now that it's dead, it is making an appearance at Dubai," he said. "I think the message is very

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(...continued)

Authorization Act for Fiscal Year 2013, 112<sup>th</sup> Cong., June 4, 2012, S.Rept. 112-173.

<sup>44</sup> The provision typically states, "None of the funds made available in this Act may be used to approve or license the sale of the F-22 advanced tactical fighter to any foreign government." (In Section 8067 of the FY2006 defense appropriations act, the aircraft's designation was changed to F/A-22. For a discussion of this designation, see footnote 18. The aircraft's designation reverted to F-22 in Section 8058 of the FY2007 defense appropriations act.)

<sup>45</sup> "Proposed Japanese F-35 Sale Announced," *Airforce-magazine.com*, May 4, 2012.

<sup>46</sup> Jim Wolf, "U.S. to mothball gear to build top F-22 fighter," *Reuters.com*, December 13, 2011.

clear: The political types over in the Pentagon wanted it gone. Now, it's not a problem for them any more." There was discussion of sending the plane to Paris, but around the time of the Paris Air Show, "what [Defense] Secretary [Robert] Gates and people around him did not want was to underscore how valuable the plane was at a time when they were trying to kill it," Thompson said.

Now that the Air Force's purchase has been limited to 187 planes, showing off the United States' most advanced fighter jet is less sensitive.

On the other hand, the F-22's appearance at the Dubai show will come shortly after President Barack Obama signed the Defense Authorization Act for 2010, which includes language about a version of the aircraft for export.

By about six months from now, Gates, coordinating with Secretary of State Hillary Clinton, is to submit a report to Congress on potential foreign military sales of the restricted aircraft. The report will include cost estimates for developing an "exportable version" of the F-22 and analysis of the strategic implications for the United States of such sales.

A second report will look at the impact on the U.S. aerospace industry of foreign F-22 sales, and the advantages and disadvantages of such sales for sustaining that industry.

"I don't think that we've heard the end of the story on the F-22," said John Pike, director of Global-Security.org, an Alexandria, Va., think tank focused on defense and intelligence. "There are people in the Air Force who still think we need twice as many [F-22s] as we've got on order. They are continuing to look for options as to how to keep that alive" and keep the production line open.

One option would be foreign sales, of course, and interested countries could include Israel and Japan.

"To maintain air supremacy beyond the foreseeable future, you go with the F-22," Pike said. "Who wants to do that? The Israelis do and the Japanese do." But representatives from Lockheed Martin, the maker of the F-22, and the Air Force didn't bite when asked about what the plane's appearance in Dubai means for potential foreign sales.

"Our one customer is the U.S. Air Force, and any sales of F-22s to other countries would be determined by the USAF, Department of Defense and State Department, subject to congressional approval," said Lockheed spokesman Jeffery Adams.

"The U.S. policy on foreign military sales for the F-22 weapons program remains restricted," a U.S. Air Force spokeswoman said. "The F-22 is a cutting-edge, fifth-generation fighter that offers unparalleled capability. It is for this reason that F-22 will not be available for foreign sales." As of Oct. 1, the Air Force had 147 of the 187 planes it will receive.

The Defense Authorization Act language is no guarantee of foreign sales—not by a long shot, Pike said. Whether that language represents something "that might have legs or whether this is something everybody knows is a non-starter" is still an open question, he said. Thompson dismissed the notion that an exportable version will be produced.

“There will not be a production line from which to sell F-22s overseas by the time an export version could be created,” he said. “Most of the skill in any major weapons system resides in the workers, and they will drift away” as production for the Air Force concludes.<sup>47</sup>

An October 23, 2009, press report states:

The Air Force has told F-22A Raptor prime contractor Lockheed Martin not to expect foreign sales of the fifth-generation fighter, a company official acknowledged this week.

“That is the guidance that we have received for post-production planning was that we are to assume no” foreign military sales, Tim Ryan, director of F-22A strategic plans and sustainment for Lockheed Martin, said during an Oct. 21 presentation at an industry conference in Vienna, VA.

“For our planning purposes, we have to go in planning worst case,” he said, noting Lockheed has an understanding of production changes that would need to be made in order to build an exportable version of the fighter.<sup>48</sup>

## Issues for Congress

### Oxygen Issues

In November 2010, an F-22 crashed in Alaska, killing its pilot. Although the official accident report declared that hypoxia did not contribute to the accident, it determined that among other contributing factors, oxygen flow to the pilot had been interrupted.<sup>49</sup>

The Air Force began an effort to understand why pilots were “reporting hypoxia-like symptoms in the air. Hypoxia is a condition that can bring on nausea, headaches, fatigue or blackouts when the body is deprived of oxygen.”<sup>50</sup> At least 25 “physiological incidents” were recorded among F-22 pilots; 14 prior to the Raptor being grounded from May to September, 2011, for investigation of the issue, and at least 11 subsequently.<sup>51</sup>

The Air Force pursued numerous avenues in the process of investigating the oxygen issues. An on-board oxygen generating system was suspected of being faulty, then cleared. Charcoal canisters were installed in F-22s to neutralize toxins that were thought to have entered the oxygen supply.<sup>52</sup> Operating procedures were examined to see if starting the F-22’s engines while the plane was in its hangar allowed exhaust gases to be taken into the cockpit.<sup>53</sup> The Air Force

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<sup>47</sup> Antonie Boessenkool, “F-22 Program’s Demise Makes Dubai Debut Possible,” *Defense News*, November 9, 2009: 16. Material in brackets as in original.

<sup>48</sup> Marcus Weisgerber, “Air Force Tells Lockheed Not To Count On Foreign Sales Of F-22A,” *Inside the Air Force*, October 23, 2009.

<sup>49</sup> United States Air Force, *Aircraft Accident Investigation Board Report: F-22A, T/N 06-4125*, July 21, 2011, [http://usaf.aib.law.af.mil/ExecSum2011/F-22A\\_AK\\_16%20Nov%2010.pdf](http://usaf.aib.law.af.mil/ExecSum2011/F-22A_AK_16%20Nov%2010.pdf).

<sup>50</sup> W.J. Hennigan, “Air Force Safety Measures Attempt To Address F-22 Raptor Concerns,” *Los Angeles Times*, May 12, 2011.

<sup>51</sup> Jennifer Hlad, “Air Force Still Searching For Cause Of Sickness Among F-22 Pilots,” *Stars & Stripes*, May 9, 2012.

<sup>52</sup> Dave Majumdar, “DoD: Toxins Suspected In Raptor Grounding,” *Air Force Times*, January 13, 2012.

<sup>53</sup> Dave Majumdar, “Carbon monoxide suspected in F-22 grounding,” *Air Force Times*, July 21, 2011.

Scientific Advisory Board was convened to consider all possible explanations and recommend corrections.

During the investigation, some Members of Congress indicated concerns regarding the oxygen issue, whether F-22s were safe to fly, and whether pilots could decline to fly the aircraft.

In August 2012, the Air Force announced that the oxygen deprivation issue was due to “a ‘mosaic’ of interrelated cockpit equipment issues that led to a chain reaction of glitches resulting in symptoms similar to hypoxia.”<sup>54</sup> The equipment problems included issues with valves in vests designed to help pilots breathe during high-g maneuvers; improper “scheduling,” or programming, of those vests; and effects of the charcoal canisters added by the Air Force during the investigation in order to reduce possible toxins in the oxygen supply.<sup>55</sup>

While the valve has performed satisfactorily for pilots of older F-15 and F-16 fighters, the F-22 is designed to fly at higher altitudes, which requires continuously pumping more oxygen to the pilots, Lyon said. The valve wasn’t strong enough to prevent that higher pressure oxygen from inflating the pilots’ vests at lower altitudes.<sup>56</sup>

... the Air Force did “rudimentary testing” on the valve some years ago and found that it caused the high-pressure vest to inflate early, hampering pilot mobility. However, the vest was found to be unnecessary on the F-15 and F-16. When the vest was re-introduced on the F-22 with the same valve, the problem wasn’t detected.<sup>57</sup>

Also in response to the 2010 crash, the Air Force is “replacing handles that engage the F-22 Raptor fighter jet’s emergency oxygen system.” Difficulty in operating the backup oxygen system was cited as contributing to the crash.<sup>58</sup>

Subsequently, some commentators indicated that they did not believe the oxygen problem had been solved. The Senate Armed Services Committee, in its report accompanying the FY2013 Defense Authorization Act (S.Rept. 112-173), directed the Secretary of the Air Force:

to explain, no later than 90 days after enactment of this Act, how the Air Force has implemented or will implement each of the recommendations provided by the (Air Force Scientific Advisory Board to address F-22 oxygen issues) If the Secretary disagrees with any of these recommendations, he should explain why and describe what other corrective actions he may be taking to respond to the concern underlying that recommendation.

Finally, as the Air Force continues to investigate this matter, the committee will view as unacceptable any act of retaliation against any F-22A Raptor pilot who raises concerns about the safety of this aircraft or declines to fly it on that basis. Although the F-22 achieved IOC

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<sup>54</sup> Michael Fabey, “USAF Deciphers ‘Mosaic’ Of F-22 Oxygen Supply Problems,” *Aerospace Daily*, August 1, 2012.

<sup>55</sup> Ibid.

<sup>56</sup> David Lerman, “Air Force Targets Valve To Fix F-22 Jet’s Oxygen Problems,” *Bloomberg News*, August 1, 2012. See also, *inter alia*, Pat Host, “Air Force Blames Faulty F-22 Pressurization ‘Schedule’ For Pilots’ Hypoxia-Like Symptoms,” *Defense Daily*, August 1, 2012; Dave Majumdar, “USAF working on ‘non-minor fix’ for F-22 oxygen problem,” *FlightGlobal.com*, September 25, 2012; and Hugh Lessig, “Raptor Problems: No One Cause,” *Newport News Daily Press*, August 1, 2012.

<sup>57</sup> Hugh Lessig, “Raptor Problems: No One Cause,” *Newport News Daily Press*, August 1, 2012.

<sup>58</sup> Mary Pemberton, “F-22 fighters retrofitted after Alaska crash,” *Air Force Times*, March 20, 2012.

in December 2005, in-service F-22s continue to experience relatively low mission-capable rates, and are expensive to maintain.<sup>59</sup>

## **Procuring Additional F-22s**

### **Introduction**

Until F-22 production ended, a key issue for Congress was whether to approve ending F-22 procurement at 187 aircraft, or reject that proposal and provide funding to procure additional F-22s in FY2010 and/or subsequent fiscal years. The issue emerged as a high-profile item of debate on the FY2010 defense budget. The White House vowed to veto any bill that supports the acquisition of F-22s beyond the 187 that had been procured through FY2009.

In past years, the issue of how many F-22s to procure has been a topic of apparent disagreement between the Office of the Secretary of Defense (OSD) and Air Force leaders, with OSD supporting a total of 183 (now 187), and Air Force officials supporting procurement of substantially more than that.<sup>60</sup> Disagreement on the issue appeared to come to a head in June 2008, when Secretary of Defense Robert Gates asked the Secretary of the Air Force and the Air Force Chief of Staff to resign. It was reported in press articles, and later confirmed by the former Air Force Secretary, Michael Wynne, that their reluctance to support a total of no more than 183 F-22s was the key factor leading to their resignations.<sup>61</sup>

The potential costs of restarting production (discussed in “Potential Production Restart” above) may significantly change the economic argument for procuring more F-22s, were the United States to bear all of the restart costs. If production is restarted (e.g., to provide F-22s to a foreign buyer), the United States might be able to acquire additional F-22s more economically than were it to restart production solely to increase the U.S. F-22 fleet.

### **Summary of Arguments**

Independent of the startup costs, arguments can be made both for and against increasing the size of the U.S. F-22 fleet.

Supporters of maintaining the current fleet size could argue one or more of the following:

- Procuring additional F-22s would add to total F-22 fleet maintenance and sustainment costs, reducing funding available for other Air Force programs.

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<sup>59</sup> U.S. Congress, Senate Committee on Armed Services, Report to accompany S. 3254, the National Defense Authorization Act for Fiscal Year 2013, 112<sup>th</sup> Cong., June 4, 2012, S.Rept. 112-173.

<sup>60</sup> The figure of 187 aircraft includes the four F-22s funded in the FY2009 supplemental appropriations bill. Prior to this, the apparent disagreement between OSD and Air Force officials was whether to end F-22 procurement at 183 aircraft or procure substantially more than 183.

<sup>61</sup> See, for example, “Wynne speaks out; Tell-all interview covers Iraq withdrawal, nuclear report, procurement and more.” *Air Force Times*. July 21, 2008. and John T. Bennett. “Wynne Talks About His Tenure, Termination.” *Defense News*. July 14, 2008.

- A projected Air Force fighter gap of up to 800 aircraft by 2024 that Air Force officials identified in 2008 testimony<sup>62</sup> is open to question, because the projection is strongly influenced by assumptions on threats and whether the United States will fight alone or as part of a coalition.<sup>63</sup> Even if such a fighter gap does emerge, procuring F-22s is not necessarily the most cost-effective way to address it—other potential options for addressing the shortfall would include procuring less expensive aircraft, such as F-35s, upgraded F-15s, or upgraded F-16s.

Advocates of acquiring additional F-22s could argue one or more of the following:

- In the fall of 2011, the Obama Administration announced a reorienting of U.S. defense strategy to focus on the Pacific. (See CRS Report R42448, *Pivot to the Pacific? The Obama Administration's "Rebalancing" Toward Asia*, coordinated by Mark E. Manyin.) With the deployment distances and air defense environments found in the Pacific theater, it is uncertain whether the current number of F-22s would be sufficient to meet U.S. strategic goals.
- As the Air Force continues to gain operating experience with F-22s, the aircraft's mission-capable rate will increase, and F-22 maintenance costs per flight hour will come down. F-22 mission-capable rates are increasing. (See "Reliability and Maintainability of In-Service F-22s" below.) Although the F-22 is an expensive aircraft to operate, the F-22's capabilities are worth the costs.

The F-35 program<sup>64</sup> continues to run behind schedule, and the resulting aircraft will not be as capable as the F-22 in some scenarios, even though its unit cost is approaching that of the F-22. Procuring additional F-22s for the U.S. Air Force could be of value in maintaining Air Force capabilities and force structure in the event of a reduced or delayed F-35 buy. The House Armed Services Committee stated, "The committee notes that without advanced fifth generation aircraft that the United States may be significantly limited in its ability to project power in the future. In addition, the committee believes that the 187 F-22 Raptors currently planned for may not alone provide enough of this capability."<sup>65</sup>

## **Reliability and Maintainability of In-Service F-22s**

A second issue for Congress for the F-22 program concerns the reliability and maintainability of in-service F-22s. Operations and sustainment now form the bulk of F-22 spending. For FY2012, "the Air Force is spending about \$803.4 million to modify and sustain the Raptor."<sup>66</sup>

In February 2009, it was reported that the F-22's mission capable rate (MCR), one measure of an aircraft's reliability and maintainability, was 60%. Critics of the F-22 noted that a 60% MCR is

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<sup>62</sup> See, for example, the testimony of Lieutenant General Daniel Darnell, Deputy Chief of Staff Air, Space and Information Operations, Plans and Requirements, at an April 9, 2008, hearing before the Airland subcommittee of the Senate Armed Services Committee Subcommittee on the FY2009 Budget for Air Force and Navy aviation programs. (Source: Transcript of hearing.)

<sup>63</sup> For a press article that presents this perspective, see William Matthews. "Coming up short: Is the Air Force's 'Fighter-gap' truth or spin?" *Armed Forces Journal International*. July 2008. p. 26.

<sup>64</sup> For more information on the F-35, see CRS Report RL30563, *F-35 Joint Strike Fighter (JSF) Program*.

<sup>65</sup> H.Rept. 112-479, accompanying H.R. 4310, p. 36.

<sup>66</sup> Michael Fabey, "USAF Focuses On Maintaining Raptor," *Aerospace Daily*, September 25, 2012.

unacceptable by the Air Force's own standards. Air Force leaders defended the F-22, arguing that the aircraft was experiencing typical growing pains.<sup>67</sup>

The Government Accountability Office found in 2010 that F-22s were encountering corrosion at unusually high rates, "and the Defense Department plans to spend \$228 million through 2016 to fix the deteriorating aluminum-skin panels."<sup>68</sup> A Lockheed spokesman said "the F-22s experienced corrosion because of 'interaction' with stealth materials used to hide them from enemy radar. Lockheed has developed alternative material that 'eliminated that interaction' and began changing the fleet in early 2010."<sup>69</sup>

## **F-22 Modernization Program**

Another potential issue for Congress for the F-22 program concerns the cost effectiveness of the F-22 modernization program (discussed in "Modernization and Sustainment of In-Service F-22s" above). Supporters of the program could argue that upgrading the F-22's air-to-ground and ISR capabilities will expand the aircraft's mission flexibility and thereby realize a greater return on the significant investment made in developing and procuring the aircraft. Air Force officials have emphasized the F-22's potential to execute many of the ISR missions that UAVs have performed in support of counter insurgency and low-intensity conflicts.<sup>70</sup>

Skeptics could argue that upgrading the F-22's air-to-ground and ISR capabilities is not critical in light of the substantial air-to-ground capability of the F-35, which is to be procured in large numbers, and the ISR capabilities of other existing or planned DOD systems, including unmanned aerial vehicles (UAVs). They could argue that resolving instability problems with the F-22's advanced avionics has been a significant contributor to the program's development cost, and that adding a new feature such as an air-to-ground radar or new communications capabilities could jeopardize the progress that has been made in the F-22's avionics software. They could argue that controlling the F-22's electronic emissions is a key component of making the aircraft elusive to enemy defenses, and that if the upgrades make the F-22 less stealthy, the benefits of these modifications might not be worth the risks.

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<sup>67</sup> "F-22 Raptor Plagued by Stealth Maintenance Woes," *National Journal's Congress Daily PM*, February 20, 2009; Marcus Weisgerber, "F-22A Stealth Maintenance Issues Part of the Learning Process," *Inside the Air Force*, February 27, 2009; Marcus Weisgerber, "Lockheed: F-22A Raptor Meets All Key Performance Parameters," *Inside the Air Force*, January 30, 2009.

<sup>68</sup> "GAO: F-22s Are Corroding, Need Costly Fix," *Bloomberg News*, December 17, 2010.

<sup>69</sup> *Ibid.*

<sup>70</sup> See, for example, Michael Bruno. "Air Force ISR Chief Foresees Downplaying 'F' in F-22, F-35." *Aerospace Daily & Defense Report*. June 22, 2007. Although the F-22 may have effective on-board sensors and the ability to receive additional information from other ISR platforms, it has limited ability to transmit targeting information to other platforms or command and control (C<sup>2</sup>) assets. This restricted communications capability was intended to make the F-22 more elusive to enemy defenses. In August 2008, it was reported that Air Force officials wanted to reprogram \$85 million to accelerate an upgrade that would enable the F-22 to more effectively share information with other aircraft. (Marcus Weisgerber, "Air Force Loots to Shuffle \$85 Million to Accelerate F-22A Mods," *Inside the Air Force*. August 8, 2008.)

## Potential Sales to Other Countries

A further issue for Congress for the F-22 program concerns the potential export of the aircraft to other countries. As mentioned earlier, Congress from time to time has reconsidered the annual prohibition on foreign sales of the F-22. Some Members in 2009 reportedly have expressed interest in reconsidering the annual prohibition, although the economics of restarting the now-closed production line may affect that calculation.<sup>71</sup>

## Legislative Activity in 2012

### FY2013 Funding Request

The Administration's proposed FY2013 defense budget requests \$283.9 million in FY2013 procurement funding for modification of in-service aircraft and \$36.7 million to facilitate Air Logistics Centers to perform F-22 maintenance. The Administration's proposed FY2013 defense budget also requests a new start program, funded at \$140.1 million in research and development, for the Increment 3.2B software; and \$371.7 million in FY2013 research and development funding for F-22A Squadrons.

### FY2013 Defense Authorization Act (H.R. 4310/S. 3254)

#### House

The House Armed Services Committee, in its report (H.Rept. 112-479 of May 11, 2012) accompanying H.R. 4310, recommends authorizing the requested amounts for F-22 without amendment.

#### Senate

The Senate Armed Services Committee, in its report (S.Rept. 112-173 of June 4, 2012) on S. 3254, recommends authorizing the requested amounts for F-22 without amendment. The report includes the following related provisions:

***Treatment of certain programs for the F-22A Raptor aircraft as major defense acquisition program (sec. 142)***

The committee recommends a provision that would require that the Air Force report F-22A modernization and upgrade programs under the system of the Selected Acquisition Reports (SAR). The committee was informed that, with new production of the F-22A coming to an

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<sup>71</sup> See, for example, Marcus Weisgerber, "Rep. Granger Would Take Another Shot At Repealing F-22A Export Ban," *Inside the Air Force*, March 27, 2009; Tony Capaccio, "Inouye Wants To Study Possibility Of Lockheed F-22 Export Model," *Bloomberg.com*, June 4, 2009; Sam Lagrone, "U.S. Senator Talks of Selling F-22s to Allies," *Defense News*, June 8, 2009; Michael Bruno, "F-22 Concerns Persist In Senate," *Aerospace Daily & Defense Report*, June 10, 2009: 3; Marcus Weisgerber, "Murtha, Young to Discuss F-22 Exports with Obey," *InsideDefense.com (DefenseAlert – Daily News)*, June 24, 2009; David A. Fulghum and John M. Doyle, "Japanese Officials Could Be Offered A \$290 Million F-22," *Aerospace Daily & Defense Report*, June 26, 2009: 1-2.

end, the Air Force intends to stop reporting within the SAR system on the F-22A, despite the fact that there could be as much as \$11.7 billion remaining to be spent on defined F-22A upgrade programs. The committee believes the category 'major defense acquisition programs' is not limited only to programs that are acquiring brand new weapon systems, and that any F-22A program for modifications or upgrades, if it would otherwise meet the statutory definition of a major defense acquisition program, should be treated that way.

The committee believes there is ample justification for continuing to track F-22A modernization past the end of new production.

(1) In April 2012, the Government Accountability Office (GAO) issued a report on the program to modernize the F-22A Raptor fleet, estimated to cost almost \$10.0 billion through 2023. In this report, GAO noted that similar efforts to modernize Air Force and Navy tactical fighters in the past involved building upgrades into newly produced jets, resulting in entirely new, fresh airplanes.

(2) In another report, issued in May 2012, GAO found that the total projected cost to modernize the F-22A Raptor fighter jet more than doubled from \$5.4 billion to \$11.7 billion since the program started and the schedule for delivering full capabilities slipped 7 years from 2010 to 2017.

(3) Upgrades to the F-22A are much more complicated than those made to other legacy fighters, giving rise to likelihood of schedule slips and cost growth.

(4) With these factors in mind, GAO believes that many of the Air Force's F-22A Raptors may not get their long-promised capability upgrades until they will have, in some cases, expended as much as 20 percent of their service lives. This could limit the amount of utility the Air Force will be able to extract from this enormously expensive modernization program.

### ***F-22A Raptor Sustainment***

In addition to the near-term modernization, sustainment over the life cycle of a weapon system represents a significant expenditure of resources. On average, about two-thirds of the total life cycle cost of a major defense system lies in post-production—in its operation and sustainment over its useful life. If that rule were to hold true, with a charge of roughly \$79.0 billion to buy the F-22A, the Air Force could be facing a demand for roughly \$160.0 billion in F-22A sustainment costs. Moreover, under its 'structures retrofit program', over the next few years the Air Force will need more than \$100.0 million to retrofit the F-22A fleet just to ensure these aircraft can fly for the full 8,000 hours for which they were designed. Over just the last 2 years, the Air Force issued sole-source contracts for sustainment of the F-22A fleet to the prime contractor totaling almost \$1.4 billion.

The Air Force recently completed an F-22A sustainment strategy review that concluded that a joint contractor/government approach could save more than \$1.0 billion in sustainment costs over the life of the aircraft. The committee believes that the Air Force must transition its sustainment strategy to adopt the least expensive sustainment strategy now, while continuing to be aggressive in exploring opportunities to compete F-22A sustainment work.

### ***F-22A Raptor Pilot Air-Supply Problems***

The Air Force has been having problems with the oxygen-supply for its F-22A Raptor pilots. The committee is aware of, and has been closely monitoring, these problems. The Air Force has documented 11 reported incidents of hypoxia-like symptoms in 10,000 sorties (about 0.1 percent) since late 2011, with 6 of these incidents having occurred as recently as February and March 2012. Since reports of pilots experiencing hypoxia-like symptoms in flight first

arose, the Secretary of the Air Force, among other actions, directed the Air Force Scientific Advisory Board (SAB) to conduct a quick-look study; gather and evaluate information; and recommend any corrective actions on aircraft using on-board oxygen generation systems. Unfortunately, to date, the Air Force has not been able to identify conclusively a root cause for the problem. But, the committee has been assured that the Air Force has put in place measures intended to ensure that these aircraft are safe to fly, including new commercial oxygen status sensors and emergency oxygen handles in the aircraft. For this reason, after having grounded the fleet after initial reports of hypoxia-related symptoms in its pilots late last year, the Air Force returned the F-22A to flying under its full mission envelope and, in fact, deployed it to Southwest Asia and the United Arab Emirates in late April. Despite that a small number of pilots have asked not to fly the F-22A or to be reassigned because of this issue, Air Force leadership has conveyed to the committee that, while the Air Force continues to investigate this problem, these aircraft are safe to fly today.

Notably, the Navy had similar problems with F-18s; there were 64 incidents from 2002 to 2009, resulting in 2 deaths. Ultimately, however, the Navy overcame these problems. The committee remains hopeful that the Air Force will be similarly successful. In the meantime, the committee will continue to exercise close oversight of this problem and how the Air Force addresses it. The committee directs the Secretary of the Air Force to explain, no later than 90 days after enactment of this Act, how the Air Force has implemented or will implement each of the recommendations provided by the SAB. If the Secretary disagrees with any of these recommendations, he should explain why and describe what other corrective actions he may be taking to respond to the concern underlying that recommendation.

Finally, as the Air Force continues to investigate this matter, the committee will view as unacceptable any act of retaliation against any F-22A Raptor pilot who raises concerns about the safety of this aircraft or declines to fly it on that basis.

## **FY2013 Defense Appropriations Bill (H.R. 5856)**

### **House**

In its report (H.Rept. 112-493 of May 25, 2012) on H.R. 5856, the House Appropriations Committee recommends authorizing \$333.9 million in FY2013 for modification of in-service F-22s, an increase of \$50.0 million from the Administration's request. The committee's report states:

#### **F-22 BACKUP OXYGEN SYSTEM**

The Committee is concerned by the continuing problems with hypoxia-type events involving the F-22 and the Air Force's inability to determine a remediable root cause for this problem. As the military's only operational fifth generation fighter, the F-22 is critical to the implementation of the National Defense Strategy. Due to the small size of the F-22 fleet, and the utmost importance of preserving the safety and readiness of F-22 pilots, the Committee strongly supports Air Force efforts to address this problem. The Committee understands that the Air Force is in the final stages of selecting a design for an automated backup oxygen system as a mitigation measure. The Committee's recommendation therefore includes \$50,000,000 only for the procurement and installation of a backup oxygen system for the F-22. The Committee further directs the Air Force to provide regular updates to the Committee on physiological events involving F-22 pilots, impacts on flight operations, and the progress of efforts to discover and implement solutions.

**Section 8057** would prohibit the use of funds made available in the bill from being used to approve or license the sale of the F-22 to any foreign government. This is the so-called Obey amendment on the F-22 program that has been included in annual DOD appropriation acts since FY1998.

## **Senate**

The Senate Appropriations Committee, in its report (S.Rept. 112-196 of August 2, 2012) on H.R. 5856, recommends a \$4.4 million addition to the Administration's request for FY2013 procurement funding for the modification of in-service F-22s. The recommended \$4.4 million addition includes a recommended reduction of \$17.5 million for "Engine modifications – excessive cost growth," and a recommended addition of \$21.5 million for "Backup oxygen system." (Page 145, line 39) The committee included the following language regarding oxygen systems:

*F-22 Automatic Backup Oxygen System [ABOS].*—The fiscal year 2013 budget request includes no funds for the F-22 ABOS. The Committee notes that following submission of the fiscal year 2013 budget request, the Air Force was directed by the Secretary of Defense to take additional measures to ensure the health and safety of the airmen and maintainers operating the F-22, to include expediting the installation of an automatic backup oxygen system. The Committee understands that the fiscal year 2013 funding requirement for the procurement of ABOS is \$21,500,000 and that the Air Force intends to defer other, previously funded critical reliability improvements to the F-22 in order to accelerate the procurement and installation of ABOS. The Committee does not agree with this strategy and recommends an additional \$21,500,000 in fiscal year 2013 to execute the accelerated ABOS schedule without negatively impacting other reliability projects.

Section 8038 of H.R. 5856, as reported by the committee, would retain and modify the annual provision regarding foreign sales of the F-22. The text of the provision as reported by the committee is as follows:

*Sec. 8038.* None of the funds made available in this Act may be used to approve or license the sale of the F-22A advanced tactical fighter to any foreign government: Provided, That the Department of Defense may conduct or participate in studies, research, design and other activities to develop a future export version of the F-22A that protects classified and sensitive information, technologies and U.S. warfighting capabilities.

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